

ARL Eye Safer Fiber Laser Testbed LabView Automation and Control

by Jun Zhang and Arayut Amnuaysirikul

ARL-TR-6605

September 2013

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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188		
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1. REPORT DATE (DD-MM-YYYY) September 2013		2. REPORT TYPE Final		3. DATES COVERED (From - To) June 2011 to August 2012	
4. TITLE AND SUBTITLE ARL Eye Safer Fiber Laser Testbed LabView Automation and Control			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Jun Zhang and Arayut Amnuaysirikul			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Laboratory ATTN: RDRL-SEE-M 2800 Powder Mill Road Adelphi, MD 20783-1197			8. PERFORMING ORGANIZATION REPORT NUMBER ARL-TR-6605		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT <p>The Eye Safer Fiber Laser Testbed is the state-of-the-art 1.2 kW, 1530-nm diode pumped fiber laser facility under construction at the U.S. Army Research Laboratory (ARL). The laser testbed consists of 40 fiber-coupled diode laser modules, a high power multimode fiber combiner, 20 power supplies, and a water chiller. It is required that all this high power equipment to operate together to produce laser output. A LabView program and control electronics has been developed and built for the testbed auto operation, monitoring, and testing. In addition, laser interlock safety for the kilowatt power operation has also been implemented in the emergency shutdown automation process.</p>					
15. SUBJECT TERMS Fiber laser, er-doped, resonantly pumped, power scaling					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 16	19a. NAME OF RESPONSIBLE PERSON Jun Zhang
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) (301) 394-1827

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1. Introduction/Background

The Eye Safer Laser Testbed at the U.S. Army Research Laboratory (ARL) is a state-of-the-art multi-kilowatt, 1530-nm diode pumped fiber laser facility. It is funded by the High Energy Laser (HEL) Joint Technology Office (JTO) and ARL cost-sharing investment. The testbed is to be completed by fiscal year 2013 (FY13). This facility will provide a multi-kilowatt, diode-pumped source for the power scaling in ARL's low quantum-defect, resonantly pumped, erbium fiber laser research work. Additionally, it will serve as a general platform of eye safer wavelength efforts within the HEL communities.

This report lays out the testbed automation effort and results. The testbed is mainly divided into three component parts: LabView control, power sources, and water chiller. The first component is the LabView control. The major function is to control 20 power supplies and monitor the current and voltage of each diode. In addition, it monitors and shuts down the power supplies when somebody tries to break the interlock and the event of an emergency, such as a power failure. The second component, the power sources, directly sends current and voltage to power up the laser diodes. Each power supply has enough power to operate up to two laser diodes. The third component is the water chiller, which dissipates the built-up heat and maintains the temperature of the entire system. These three major components connect to fiber laser diodes that are combined to the pump coupler. Then, it outputs 1–2 kW pump to fiber Bragg grating (FBG) optics. Figure 1 shows a diagram of the testbed.

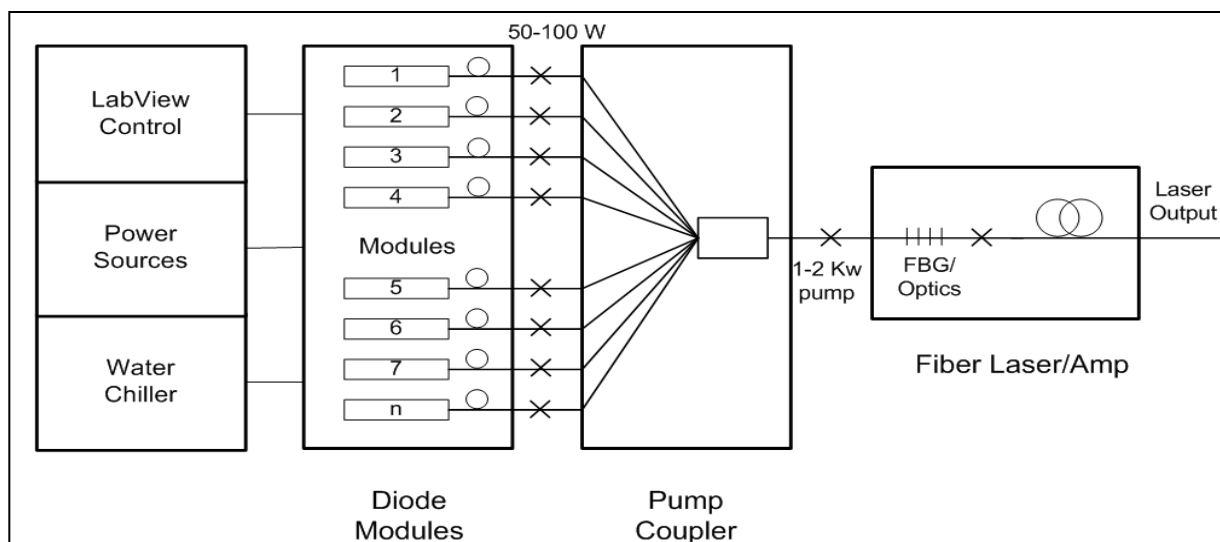


Figure 1. Eye safer diode laser testbed diagram.

2. Experiment/Calculations

2.1 General Procedure and Flow Chart

The process begins as follows (figure 2):

1. Check all equipment such as power supplies, laser diodes, the water chiller, hoses, and cable.
2. Turn on LabView and begin to input the parameters. If there is an error, LabView will shut down all the power supplies.
3. Continue the operation of and monitoring by the LabView software. It will begin to shut down the testbed in the event of a false situation, for example, an unusual level of current or voltage, interlock breaking, or abnormal output power.
4. If everything works perfectly, let the test manually shutdown the LabView and equipment.

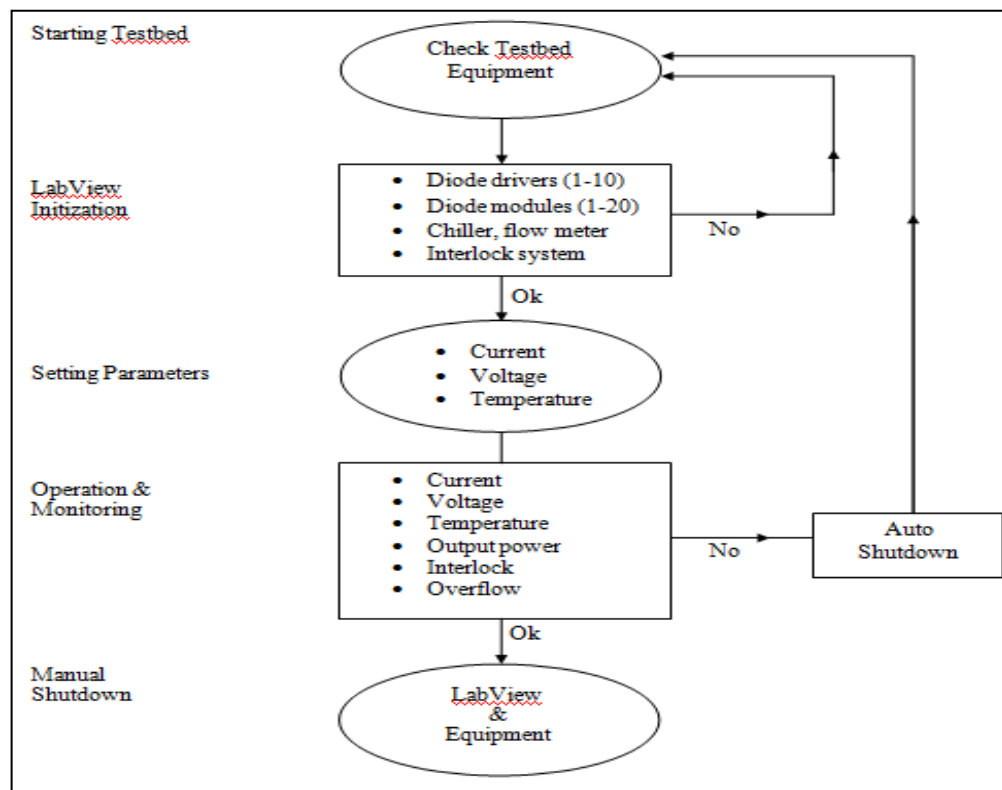


Figure 2. Control flow chart.

2.2 Power Sources

There are a total of 20 power supplies connected in the daisy-chain connection (figure 3). Each power supply is capable of powering up to 1.5 kW, and the maximum output current is 12 A. In order for these power supplies to communicate throughout the testbed, we must create a unique address to each power supply by naming each unit by some number (from 1–31). Only the first unit is connected to the PC via RS 232, and other units were connected via a RS 485 interface. These are linked using RS 232/485 cable from “in” position to “out” position.

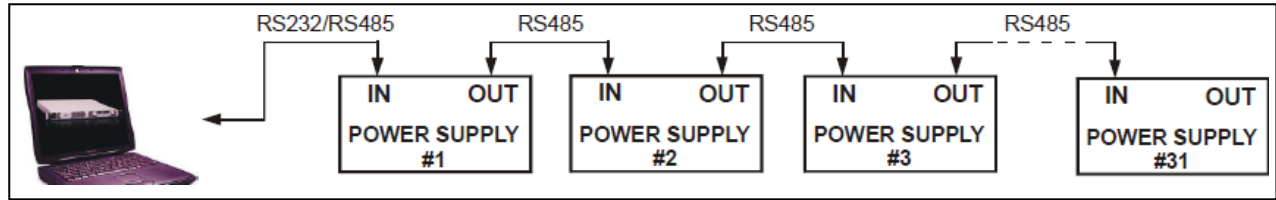


Figure 3. Power supplies connected in the daisy-chain connection.

One part of the experiment was to automate the power supplies. In order to control several diode modules simultaneously, we used LabView software to operate. As figure 3 shows, the power supplies could be connected up to 31 units by a daisy connection. Only the first unit was connected to PC via a RS 232, and the other units were connected via a RS 485 interface. The main part of controlling was quite simple. First, we needed to create the unique address of each power supply by naming each unit by some number (from 1–31). For single controlling, we used the scroll box to select the power supply address and entered the number of voltages and currents. For two or multiple power supplies, we had to execute the global command, for example, using “gpc 4” to tell all power supplies to send a 4-A current, and “gpv 50” to send 50 V. (See table 1 for full details on the commands)

Table 1. Output commands.

Output Commands	Description
gpv n	Set the output voltage value in volts.
gpc n	Program the output current value in amperes.
grst	Reset and bring the power supplies to safe state.
gout n	Turn the output on/off: gout 1 = turn on, gout 0 = turn off

Figure 4 shows the front panel of power supplies and back panel RS 485 link.



Figure 4. Front panel of power supplies and back panel RS 485 link.

2.3 Water Chiller

The water chiller module (figure 5) also plays a major function in the testbed because without sufficient cooling power the whole procedure in the test will collapse. The LYTRON water chiller can cool down 40 diode lasers simultaneously. The specifications of the water chiller are a capacity of 5,900 W at 20 °C delivery water and 20 °C ambient temperature; the cooling temperature range is +5 to +35 °C.

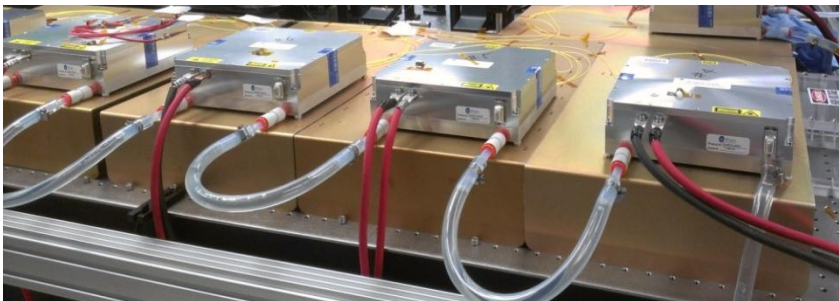


Figure 5. Water chiller and cooling.

3. Results and Discussion

3.1 LabView Automation

The operation on LabView (shown in figures 6 and 7) is a crucial part of the experiment because it monitors and examines the status of the individual power supplies. First, one selects the VISA Input to COM, and then the GEN Address and Baud rate. After that, one enters the voltage and current numbers into the configuration box and selects “RUN the LabView”. On the front panel, there is a summary table for voltage and current that updates information regarding each power supply. Moreover, the table contains the error status, which warns of any abnormal behavior or if a failure is taking place.

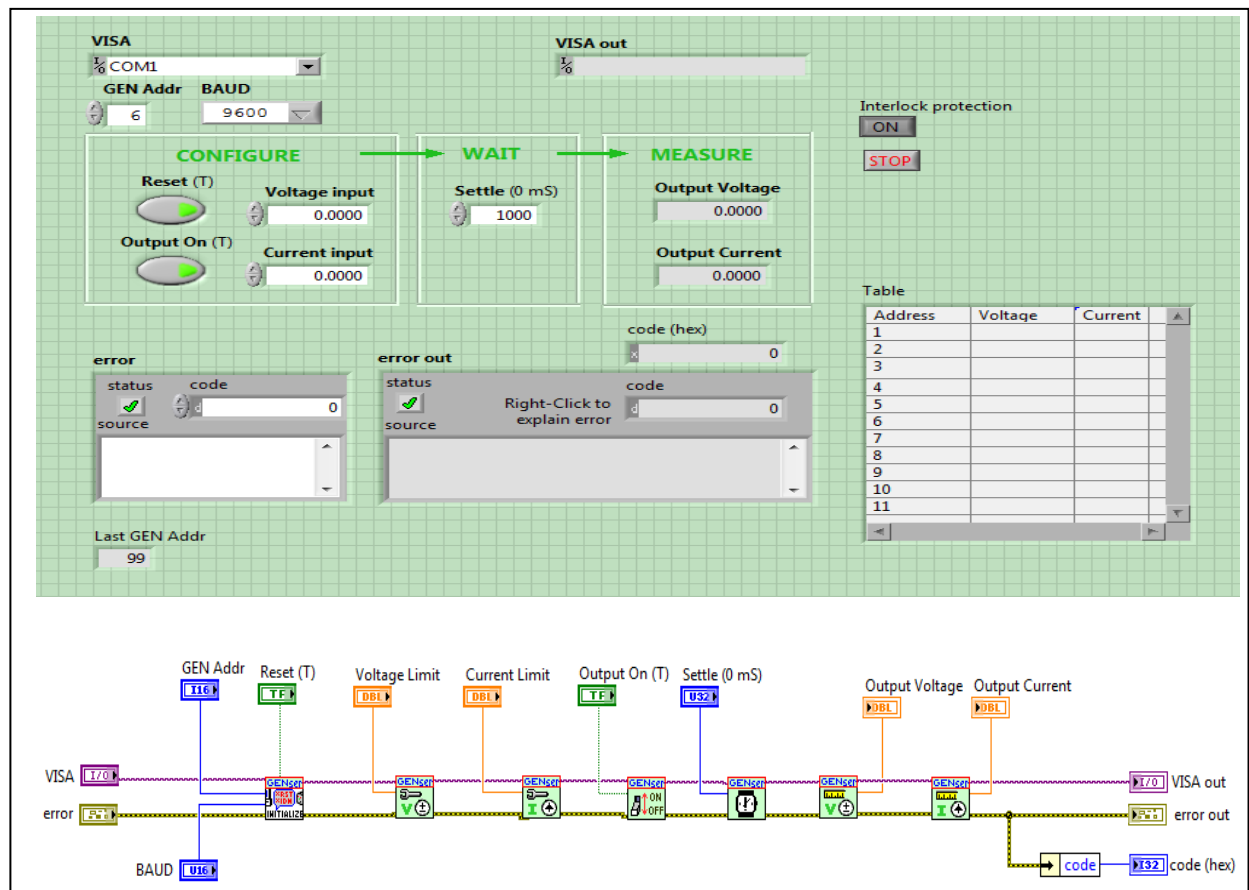


Figure 6. Front panel LabView, part 1.

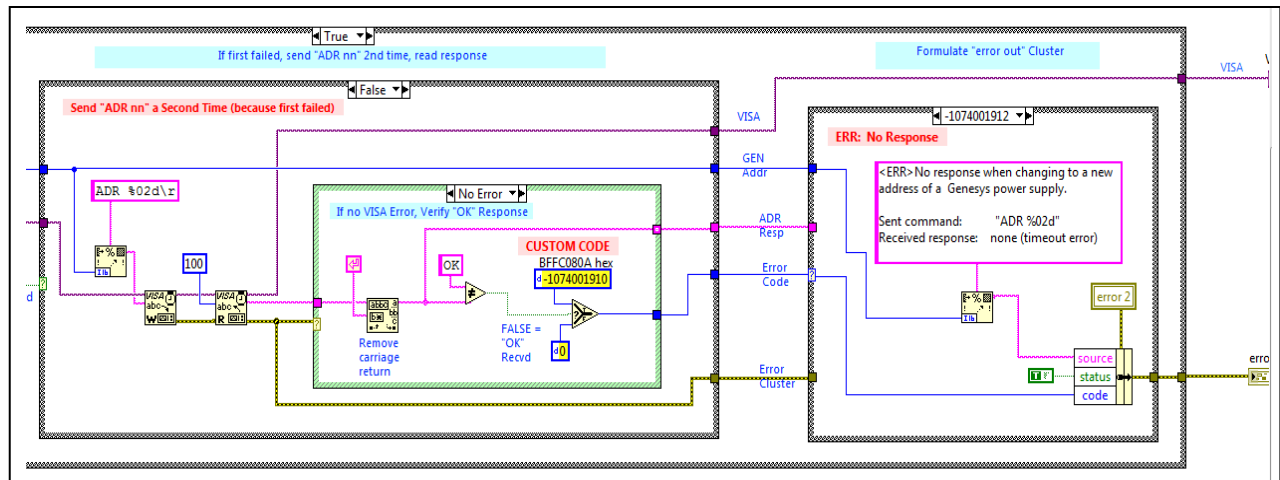


Figure 7. Front panel LabView, part 2.

3.2 Interlock System

The interlock protection system is constructed as part of LabView control (figure 8). If someone accidentally breaks into the lab, the interlock protection activates and disables the power supplies by resetting the current and voltage to zero. Also, there is the stop button to manual reset the interlock system.

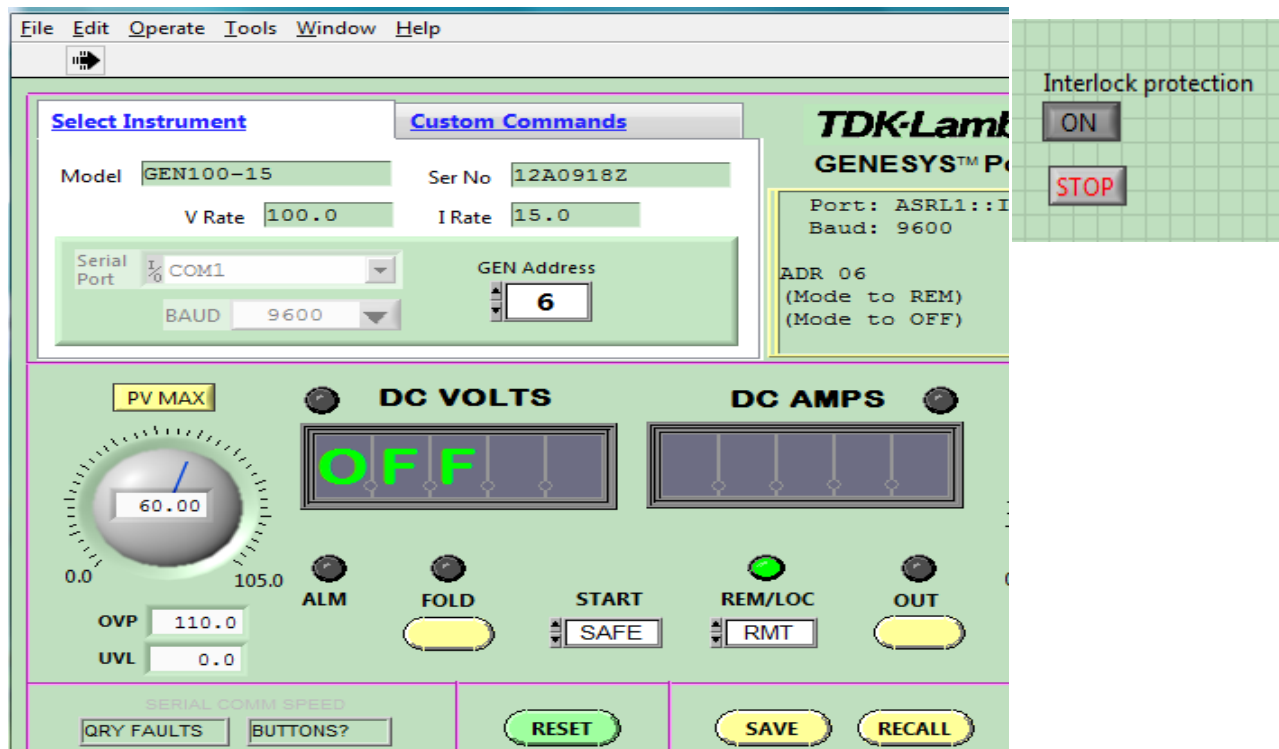


Figure 8. Interlock system.

4. Conclusion

In this project, we developed the Eye Safer Fiber Testbed. During the first couple of weeks, we sourced all the necessary parts, such as the power cables, and creating cable connects from the PC to the power supplies. At this time, the project does not have any actual data, because it is still in the development stage and is waiting for the funding. However, in the near future, we will plan to add more software detail to indicate the temperature and overflow rate for each laser diode.

5. References

1. Bishop, H. R. *LabView 7 Express Student Edition*. Upper Saddle, N.J.: Pearson Prentice Hall, 2006, pp. 114–150.
2. Lytron Web site. “About Lytron,” 2012. <http://www.lytron.com/About-Lytron> (accessed 20 July 2012).
3. Serway, R. A.; Moses, C. J.; Moyer, C. A. *Modern Physics*. Philadelphia: Saunders College, 1989.
4. *Technical Manual for GENESYSTM 750W-1500W*. TDK-Lambda America, Inc.

List of Symbols, Abbreviations, and Acronyms

ARL	U.S. Army Research Laboratory
FBG	fiber Bragg grating
FY	Fiscal Year
HEL	High Energy Laser
JTO	Joint Technology Office
VOA	variable optical attenuator

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